BT-1049

# The "C"-Launch Technique for High-Altitude Balloons

Air Force Cambridge Research Labs.

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Dec 1967

AFCRL-67-0672
DECEMBER 1967
INSTRUMENTATION PAPERS, NO. 136

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
L. G. HANSCOM FIELD, BEDFORD, MASSACHUSETTS

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This research was supported by the Defense Atomic Support Agency.

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## Abstract

During the period from 1961 through 1965, the Air Force Cambridge Research Laboratories developed the technique for launching high altitude plastic balloons directly from the manufacturer's shipping crate. This technique was primarily designed to facilitate the handling, inflation, and launch of large balloons from small ships at sea. This paper describes the new launch procedure and the specialized equipment designed to support it.

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# The "C"-Launch Technique for High-Altitude Balloons

## I. INTRODUCTION

A ship at sea provides an ideal launch platform for large high altitude plastic balloons. By running with the wind a ship can create a highly desirable "zero-wind" condition during the critical stages of balloon inflation and launch. This advantage has led to a history of balloon launches conducted at sea. As balloons and balloon payloads increased in size, however, the problem of obtaining an appropriate launch vessel became more acute. Such a vessel required the speed and maneuverability necessary to negate wind effects, a relatively large deck area to support conventional launch techniques, and an adequate storage area for the lifting gas, flight system hardware, and balloon launch equipment. These requirements limited ship selection to aircraft carriers, which were costly and of limited availability.

In 1961, Air Force Cambridge Research Laboratories (AFCRL) was asked to develop a shipboard launch technique that would circumvent the restrictions of an aircraft carrier while retaining the highly desirable properties of a shipboard launch. In accordance with this request, AFCRL developed the "C"-launch technique, a launch method that is designed for operational use aboard small vessels.

(Received for publication 13 November 1967)

## 2. DISCUSSION

Balloon design and launch methods invariably reflect ar attempt to minimize adverse wind effects on the balloon during prelaunch balloon handling and inflation. These methods, techniques, and devices include reefing sleeves and belts, restraining cable systems, protective screens and structures, and use of the "dynamic"-launch method. In addition, launch sites and times are carefully selected to take advantage of natural protection and periods of calm or minimum wind. Usually, several techniques and devices are used together to protect the balloon and to control its prelaunch development.

The conventional "dynamic"-launch method restricts the amount of slack balloon material subjected to wind drag or "sail" effect during the critical stage of balloon inflation. In this launch method, the bulk of the balloon is laid out lengthwise on a suitable launch surface. Very large balloons (26 million cubic foot displacement) have required up to 800 ft of layout space. The top portion of such a balloon (~50 ft) is placed under the roller arm of a launch arm vehicle. This vehicle confines the lifting gas to the balloon upper portion during inflation. At completion of inflation, the launch arm is released and the balloon rises vertically over its payload release vehicle. This latter vehicle maneuvers to place the balloon directly over the payload for final release and system launch. Use of this dynamic launch technique is unnecessary in calm or near calm surface winds since a calm wind will permit inflation of a vertically deployed balloon with little danger of developing hazardous "sail effects." Such a calm wind condition exists aboard a ship running downwind at a speed equal to the surface wind speed.

The "C"-launch technique inflates and vertically deploys the balloon directly from its shipping crate. Once the erect balloon is fully inflated, it is tethered over the payload in preparation for launch. This technique has the following advantages:

1. The need for an expansive launch area is eliminated. Aircraft-carrier class vessels are no longer required as launch platforms for large balloons.
2. Much less handling of the balloon is required, so that the risk of damage to the plastic envelope is considerably reduced.
3. The combination of several functions into one deployment launch device, the "C" launcher, reduces the amount of launch support equipment required.
4. Fewer launch personnel are needed.

### 2.1 "C"-Launch Equipment

The model III "C" Launcher (Figure 1) is an electrohydraulic device designed to control the inflation and prelaunch deployment of the balloon. It consists of

a tie-down and release point to which the bottom end fitting of the balloon is attached during vertical deployment and inflation, a system of rollers that controls the balloon payout rate during initial inflation, a weigh-off system that measures balloon lift during and at the completion of inflation, a winched-tether system used to deploy the inflated balloon over its payload and final release point, and a control panel through which a single operator can control these functions. The launcher has been used to successfully control the deployment of 1.15 million cubic foot Mylar scrim balloons. This balloon is approximately 200 ft long, weighs an average of 1060 lb, and is inflated to 6000 lb gross lift.

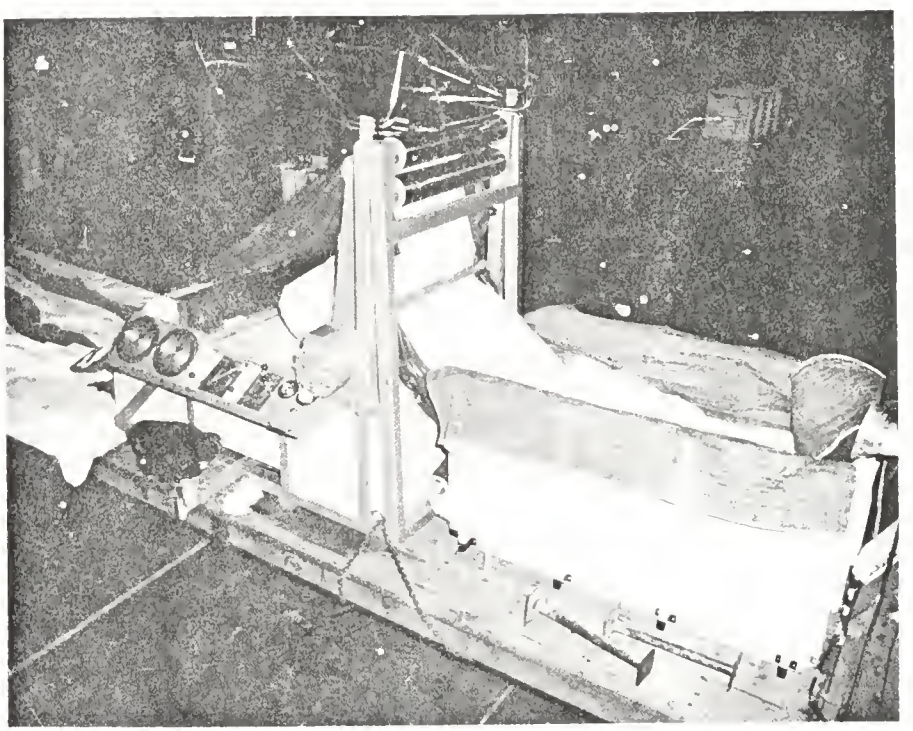

Figure 1. Model III "C" Launcher

Playout of the balloon from its crate is controlled with squeeze pressure applied through the movable roller of a three-roller squeeze system. A relief mechanism in the movable roller system allows the roller to back off as it maintains a constant operator-set pressure. This design allows passage of added balloon bulk while maintaining a constant pressure on the balloon material. The rollers are all free-wheeling to allow balloon passage with a minimum of friction between

the rollers and the balloon material. It is also possible mechanically to set a minimum roller clearance to further protect the balloon when maximum squeeze pressure is applied.

Specifications of the Model-III Launcher are as follows:

| | |
|---|---|
| Release Mechanism | Designed to withstand forces up to 30,000 lb |
| Hydraulic System | 3000 lb |
| Squeeze System | At 3000 psi, is designed to deliver 9400-lb squeeze at the rollers. The squeeze gauge at the operator's console is direct readout |
| Reservoir | 30 gal. capacity of Mobile DTE # 28-2955SSU hydraulic oil |
| Winch | Staffa Hydraulic Motor Mark 4-TU, continuously adjustable speed of 0-100 rpm with high torque, low speed capability |
| Tether Line | 400 ft length of 18,000-lb test dacron over polypropylene rope |
| Weigh-off System | Martin-Decker SD12-0060 tension-load system with free-lift reading between 0 to 6000 lb with 0.2 percent accuracy |
| Total Weight | Approximately 5000 lb |
| Covers | Kydex plastic |
| Tie-down Provisions | Will accommodate 4.5 in. Navy deck tie-down chains in order to insure a stable and secure platform under maximum load conditions |
| Gages | System pressure - 3000 psi in operation. Squeeze pressure - 125 psi normal minimum with squeeze handle at full decrease. Weigh-off - 0 to 6000 lb depending upon free-lift. |
| Controls | Power on - Push for on<br>Roller - UP, DOWN, or neutral center position<br>Squeeze - Variable between DECREASE/INCREASE POSITIONS<br>Reel in - STOP or REEL IN positions<br>Safety - Lock-on pin<br>Release - HOLD or RELEASE positions<br>Payout - Speed of payout is variable between the STOP and PAYOUT positions |
| Power Supply | External 220 V, 60 cycle, 3 phase, 10 kW Diesel generator |

The release mechanism, pictured in Figure 2, consists of a hydraulically operated bolt which serves to retain a 5/8 in. BBB coil chain connection to the Launcher release plate. The Launcher release plate is also connected to the tether line release fitting. When the balloon is ready for release from the Launcher, the tether line is drawn in, in order to slacken the Launcher release chain. As the chain slackens, the bolt is withdrawn. This procedure provides a shock-free transfer of the balloon from the launcher to the tether line during the launcher release process.

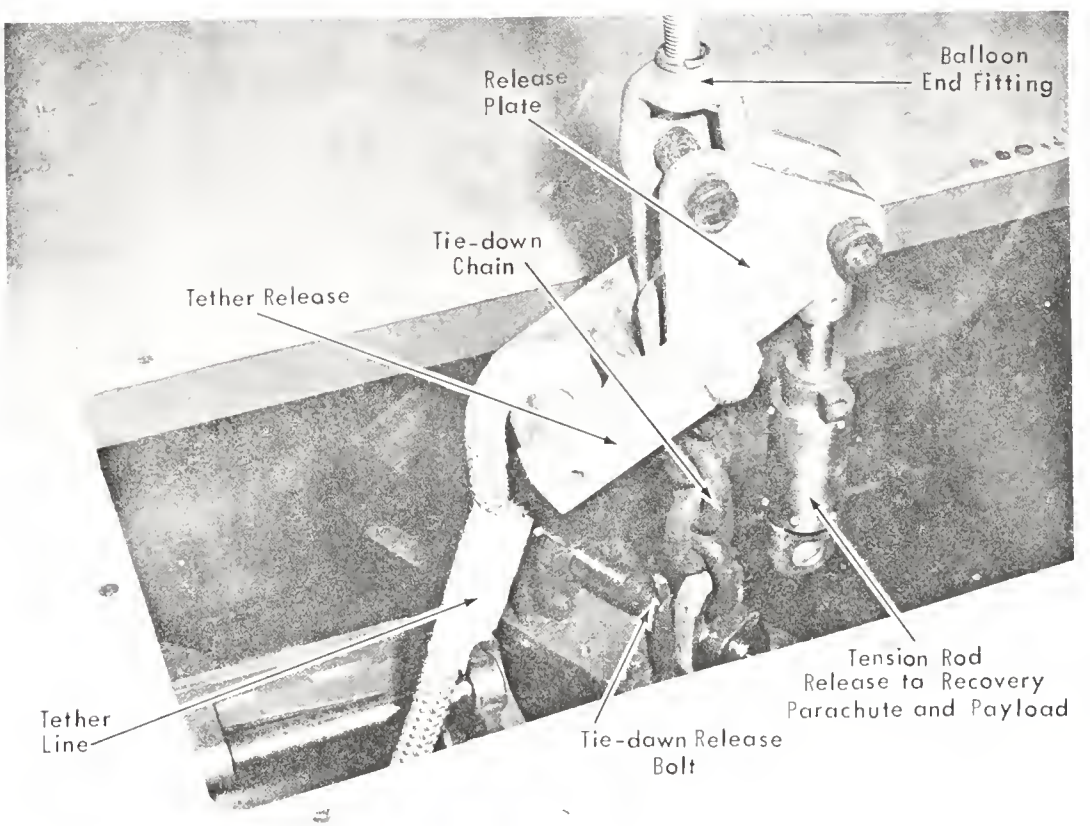


Figure 2. "C" Launcher Release Assembly

Use of the "C"-launch technique required special packaging of the balloon. A standard manufacturer's shipping crate is modified to permit removal of both the crate top and one end. The balloon bottom end fitting is folded back across the top of the folded balloon so that it can be withdrawn readily through the open end of the crate and attached to the launcher tie-down. The topmost 40 ft of balloon

is then withdrawn between the "C"-launcher rollers and placed upon a canvas lay-out cloth for initial inflation. Removal of a protective sleeve from this portion of the balloon exposes a specially folded and tied inflation tube mounted on a plastic cylinder. The folded inflation tube is slipped over an elongated gas diffuser which is attached to the gas storage system with appropriate hose. Use of this accordion-folded inflation tube permits the gas inflation crew to work close-in to the balloon during the early stages of inflation. The entire launch operation can be performed in a 30 by 60 ft area. During system development tests, launches were easily conducted from a flatbed trailer (Figure 3).

Figure 3. "C" Launch From a Flatbed Trailer

The XMSV-001 Mylar scrim balloon designed for use with the "C" Launcher is encased in a reefing sleeve that extends from the bottom end fitting to a point 40 ft below the balloon apex. This sleeve assists in balloon control during its passage through the launcher roller system and also during the continuing inflation process after the balloon is fully deployed vertically. A rip rope extends the full length of the reefing sleeve and allows the sleeve to be opened as the balloon expands during inflation, thus always maintaining a tight bubble. This protective sleeve has been designed to release automatically although in practice it may be released manually prior to balloon launch. The undeployed balloon material or "rudder" is folded in such a manner that it will be on the downwind side of the deployed portion of the balloon which tends to shield the undeployed material from the wind.

### 2.2 "C"- Launch Operation

The "C"-launch technique has been successfully demonstrated on land and at sea. During the land operations natural calm surface winds were required to simulate the shipboard conditions. The Model III "C" Launcher, which was designed to handle free-lifts up to 6000 lb, has been used to launch six XMSV-001 balloons. Although this device has not been demonstrated at sea, the Model II "C" Launcher, which was designed for loads up to 3000 lb, was used to launch 4 complete balloon systems from aboard the USS Wood County LST-1178. These launches were conducted in the U.S. Navy VACAPES Control Area during the period from 24 to 27 August 1964 in true surface winds ranging from calm to 17 knots. The ship experienced little difficulty in maintaining the desired zero-wind condition during these exercises. Ship's motion (as high as 11° of roll) posed no problems and no limitations were apparent in either the techniques employed or the equipment used. Loading of all balloon operational equipment—the "C" Launcher, balloons and flight system equipment, ground handling equipment, a command-control instrumentation van, and six helium trailers—to include adequate tie-down and preparation for sea was accomplished in less than 48 hours. Within 24 hours of returning to port the same equipment was unloaded. No permanent ship modifications were required to support the balloon launch operations. It was required, however, that all major items of equipment be electrically grounded. Storage space aboard the Wood County was plentiful with sufficient area for 16 helium trailers on the tank deck alone. Figures 4 and 5 show the helium trailer tie-downs and a portion of the work area available on the tank deck of this class LST. Figures 6, 7, 8, and 9 show various stages of inflation and launch of a 107 ft diameter, 472,500 cubic foot displacement, polyethylene balloon. This balloon is capable of raising an 1800-lb payload to a 65,000-ft altitude.

## 3. SUMMARY AND CONCLUSIONS

The "C"-launch technique has enabled conduct of balloon operations at sea from small ships. It can also be used on land during periods of low wind in remote areas where appropriate launch surfaces are not available for conventional launching techniques.

Two "C"-launch devices have been developed and successfully tested. The Model II Launcher can handle free-lifts up to 2400 lb. It has been used to launch 107 ft diameter polyethylene balloons at sea. These balloons are capable of floating 1800 lb at at 65,000-ft altitude. The Model III launcher has a capacity of up to 6000 lb of free-lift and has controlled the vertical deployment of 1.15 million cubic foot Mylar scrim balloons, floating a design payload of 4500 lb at an altitude of

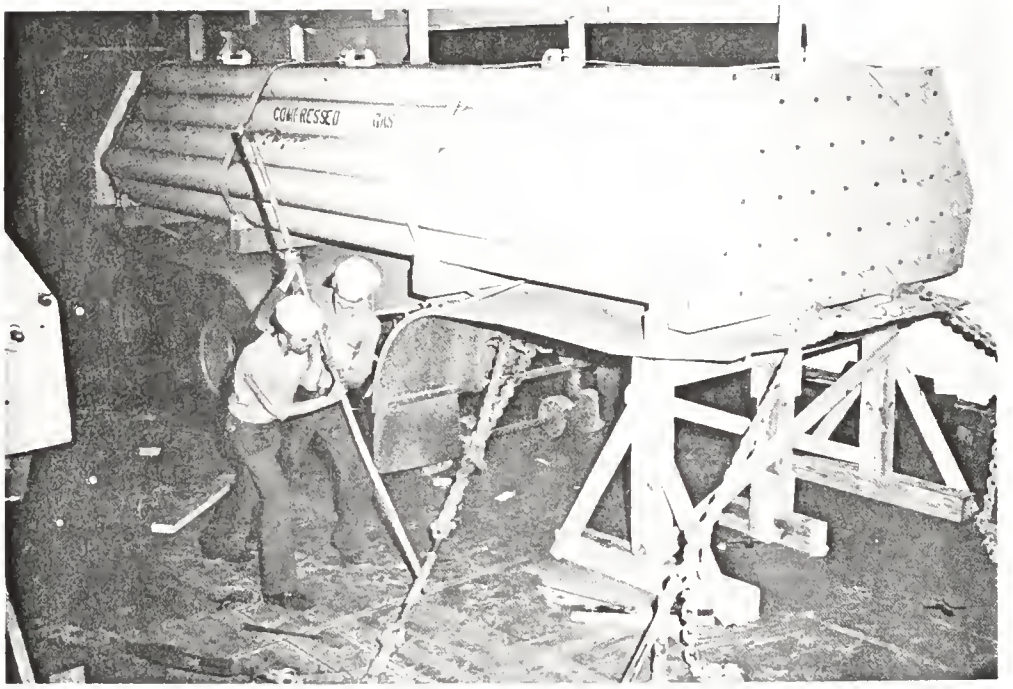


Figure 4. Helium Trailer Tie-downs

Figure 5. Tank Deck Work Area, LST 1178

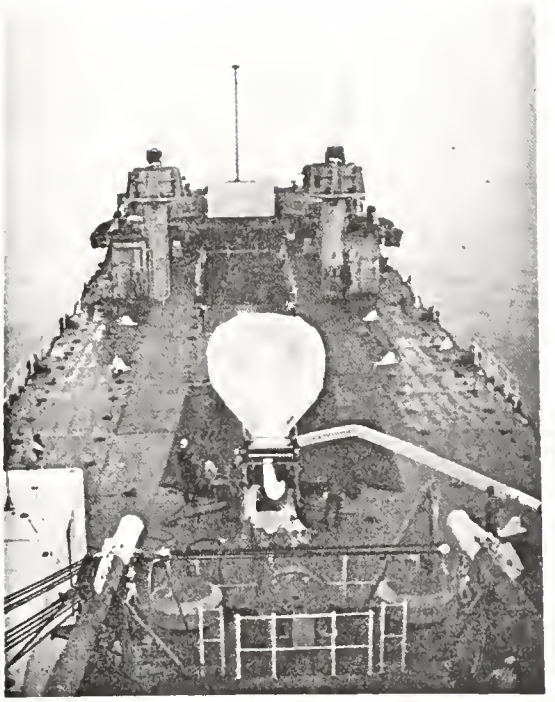

Figure 6. Initial Inflation

Figure 7. Final Inflation

Figure 8. Completion of Inflation

Figure 9. Launch at Sea

65,000 ft. With minor modifications, the Model III Launcher could handle larger balloons and heavier payloads.

Ship requirements include the following: adequate speed and maneuverability to neutralize surface winds encountered in the proposed launch area; an uncluttered deck space approximately 30 ft wide in the beam direction by 60 ft long in the fore and aft direction; sufficient space to store the required amount of lifting gas, balloon flight system, and related equipment, to prepare flight system equipment, and to establish a command/control center for flight operations. Equipment can be placed in position on board ship and removed in one to two day periods without modification to the ship.

## Acknowledgments

The authors wish to acknowledge the assistance of Mr. Sidney Rosenthal of the Engineering Support Branch of AFCRL for many of the "C"-launch system design details; Mr. Earl Harrah of AFCRL's shop facilities, who was responsible for the fabrication of the Model II "C" Launcher; and Mr. Alfred D. DeGirolamo of AFCRL, who ably assisted in the design, fabrication, and test of the "C" Launchers and related equipment.

Unclassified
Security Classification

**DOCUMENT CONTROL DATA - R&D**

*(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)*

1. ORIGINATING ACTIVITY *(Corporate author)*
Air Force Cambridge Research Laboratories (CRE)
L. G. Hanscom Field
Bedford, Massachusetts 01730

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE

THE "C"-LAUNCH TECHNIQUE FOR HIGH ALTITUDE BALLOONS

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*

5. AUTHOR(S) *(First name, middle initial, last name)*
Francis X. Doherty
Chester G. R. Czepyha, Lt. Col., USAF
Robert J. Reddy, Major, USAF

6. REPORT DATE
December 1967

7a. TOTAL NO. OF PAGES
16

7b. NO. OF REFS
none

8a. CONTRACT OR GRANT NO. Supported by DASA

b. PROJECT, TASK, WORK UNIT NOS. 5710-B1.6-02

c. DOD ELEMENT 76006015

d. DOD SUBELEMENT none

9a. ORIGINATOR'S REPORT NUMBER(S)
AFCRL-67-0672

9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
IP No. 136

10. DISTRIBUTION STATEMENT
1—Distribution of this document is unlimited. It may be released to the Clearinghouse, Department of Commerce, for sale to the general public.

11. SUPPLEMENTARY NOTES
This research was supported by the Defense Atomic Support Agency

12. SPONSORING MILITARY ACTIVITY
Air Force Cambridge Research Laboratories (CRE)
L. G. Hanscom Field
Bedford, Massachusetts 01730

13. ABSTRACT

During the period from 1961 through 1965, the Air Force Cambridge Research Laboratories developed the technique for launching high altitude plastic balloons directly from the manufacturer's shipping crate. This technique was primarily designed to facilitate the handling, inflation, and launch of large balloons from small ships at sea. This paper describes the new launch procedure and the specialized equipment designed to support it.

DD FORM 1 NOV 65 1473

Unclassified
Security Classification

| 14. KEY WORDS | LINK A | | LINK B | | LINK C | |
|---|---|---|---|---|---|---|
| | ROLE | WT | ROLE | WT | ROLE | WT |
| Balloon launch at sea<br>Balloon launch technique<br>Balloon launch equipment | | | | | | |